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EDITORIAL

THE NECESSITY FOR STANDARDS

What is Science? To the average man the word conveys a confused idea of abstruse and impractical subjects—archaeology, palaentology, entomology,—the pursuits of bespectacled old men with long hair who mutter long Latin names to themselves. He thinks of a scientist as an absent-minded old professor walking down the street with one foot on the footpath and one in the gutter and wondering all the time why he has become suddenly lame, or boiling his watch in a saucepan and timing the process by the egg which he holds in his hand. The misconception of the real nature of Science and scientific investigation dates back to the early days of modern methods. The ancients speculated on the meaning of things in general, and with surprising frequency they hit on the truth. Occasionally they would arrive at a conclusion through experiment, and it is strange that the success of such a method of investigation should not have resulted in its more frequent use. Archimedes was a true scientist. His most famous experiment, it is true, was an accident, *but he was able to apply his accidentally gained information.* How many men before Archimedes must have discovered his Principle, but lacking his powers of application, missed their opportunity to make a deathless name!

In the middle ages the methods of investigators became so corrupted by occult practices that new discoveries were discouraged and the investigators persecuted. Witches and warlocks practiced their dark arts under the constant fear of Church persecution. The Church, unwilling to discard her ancient cloak of superstition constantly stamped out the smouldering sparks of the new knowledge.

And so Science became to the popular mind a mysterious sort of a study removed from everyday life, though sometimes furnishing magical results all the more wonderful because of the ignorance of those who did not understand the underlying principles on which they were founded. Even at our present relatively advanced stage the general idea is still very much the same as it was in the middle ages, though the intolerant persecution of investigation has almost abated. We still have in our midst, however, those who would suppress the teaching of things they cannot understand, such as Evolution. Anti-vivisectionists and anti-vaccinationists continue to obstruct the onward march of progress, and people will still consult herbalists and chiropracticians instead of doctors. They have not yet realized that Science is classification and co-ordination of facts—nothing

more, nothing less. Modern scientific knowledge is the result of a slow accumulation of data. Fragment by fragment the structure has been built. Mistakes have been made and will always be made, and when they are discovered, the builders must go back and rectify them. There is the outstanding difference between the methods of the magician of the middle ages and those of the modern scientist. One tried to arrive at his result in one groping step. The other investigates his materials and reasons out what results he may expect. Sometimes his results are *not* what he expects, but he has the foundations which will enable him either to have a good idea of what will happen, or else to understand it when it does happen and be able to use it as a step towards further knowledge.

The fundamental idea of Science being the classification and co-ordination of knowledge it is obvious that standards must be adopted. Common usage in different countries has resulted in the adoption of standards within those countries, standards altogether different from those used in neighboring countries. For international use either a system of exchange must be adopted, or an arbitrary universal standard must be fixed. Perhaps the chief varying factor is language. No language is perfect. The evolution of a tongue means that all sorts of irregularities must creep in. Constant borrowing from foreign sources widens the scope of a language and improves it as a means of expression, but, at the same time, it makes it less and less amenable to set grammatical rules. A universal tongue should be capable of adapting itself to new needs as they may arise,—of being able to interpolate new words without creating exceptions in its pronunciation or declension—and also be free from liability to change in its essential nature. All languages are subject to slow change, a fact that is brought home forcibly to those who try to read Rabelais in the original French or who read Chaucer for the first time. If a universal language were adopted as a standard the same trouble as has happened in America would be liable to develop. Deviations would have to be made to suit new conditions, and in time a dialectal entity would come into being.

None of the existing languages are able to resist this tendency to break up into dialects. English, French, Spanish, all have the same weakness. Their rules are not sufficiently stringent. We must fall back on one of two alternatives. Either a dead language must be adopted or a new and artificial language with hard and fast rules must become the standard. Latin possesses certain advantages, but lacks the simplicity of modern tongues. Long years of study are necessary for its mastery. Then for modern use new words must be coined, and it is no longer Latin; it has become a new language founded on Latin grammar.

Realizing the difficulties of adapting any living or dead language to the needs of everyone. Dr. L. L. Zamenhof devised Esperanto, a beautiful tongue which combines the advantages of the various European languages without their disadvantages. The pronunciation and grammar are fixed, and the flexibility of word-formation is such that delicate shades of meaning may be expressed in a single word where in another language a whole sentence would be required.

Everyone likes his own dog best, and everyone his native language best. On that account the adoption of Esperanto will probably never be universal. Like the brotherhood of man, it is an ideal. It would make an excellent scientific medium, one easily intelligible and capable of conveying ideas quickly and accurately.

French is the language of diplomacy. Science has no *lingua franca*, but to a certain extent standardization has been established. The first and most obvious point is in the systems of mensuration and of weighing, where the metric system has been adopted, though not as universally as it should be. The binomial system of nomenclature which was adopted by Linnaeus (it was used to a certain extent before his time) was an important step in the standardization of botanical and zoological names. The language chosen was Latin and except for the confusion of genders, it is an admirable one for the purpose. The advantage of the Linnaean system is its universal nature. The fruit that an Englishman calls "apple" is "pomme" to the Frenchman, "yabloko" to the Russian, "apfel" to the German, but *Pyrus malus* is the name which is understood by them all. The drawbacks of universal biological nomenclature, however, are not to be overlooked. Once an organism has received some particularly cumbersome or inappropriate name, it is branded for ever. As the late O. Khayyam said:

> "The Moving Finger writes; and, having writ,
> Moves on: nor all thy Piety nor Wit
> Shall lure it back to cancel half a Line
> Nor all thy Tears wash out a Word of it."

Then there is the trouble which arises when two men name the same animal or plant independently. The rules are clear cut on the point. The first name given, whether it be the more appropriate or not, survives. The other becomes a synonym. The question of synonyms becomes a penchant with some authors. The name is all that interests them; the organism receives its name, and then their interest swerves to some other doubtfully labelled specimen,—another orgy of name-juggling. "Tomorrow to fresh fields and pastures new."

With the multitude of scientific journals publishing taxonomic work it is necessary to have some standard institution as a permanent authority to decide all questions of debatable character as far as nomenclature is concerned. In botany, there exists such an institution in the Royal Botanic Gardens at Kew in England. Children will always want to break away from home when they are big enough to brave the world alone, and the same is true with nations and with smaller institutions. No herbarium in the world can compare with that of Kew, but a number are sufficiently strong now to attempt to stand alone and formulate their own standards. This is a deplorable state of affairs. If we have a standard, we want one standard only, whether it be Greenwich time or Kew's ruling on nomenclature.

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THE NATURE OF THE ORGANISM FOUND IN THE FIJI GALLS OF SUGAR CANE

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TWO PLATES AND TWO TEXT FIGURES

Although Fiji disease is a now well known and widespread disease of sugar cane, its cause has never been demonstrated. Lyon (1), in 1910, called attention to "foreign plasmic bodies" present in tissues of the galls which, as he suggests, are probably the cause of Fiji disease. Lyon's first paper on the nature of these "plasmic bodies" was based on a study of formalin material; his later papers are based on a study of fresh material and carefully fixed material. In 1921 he published a more detailed account in a paper dealing with the general characters of Fiji disease (2). The data presented in the 1921 paper is based partly on a study of material collected and sectioned by Mr. D. S. North who collected material in the Fiji Islands. He states that the study of this material "strengthened his opinion that the foreign bodies were individuals of a parasitic organism, but showed that the structure of this organism did not correspond to that of any known parasite, and he (Lyon) was, and still is, at a loss to know just where in the natural system this organism should be classified." He states also, that in an unpublished manuscript, he proposed the name *Northiella sacchari* for the organism, and "that in developing galls the individuals have been observed to divide simultaneously with the nuclei which they accompany". This last is a very significant statement. His conclusion that the data then available is insufficient to locate the organism, is certainly correct. On account of the seriousness of the disease here in the Laguna region, I have been forced to investigate its cause. After weeks of study I felt like Mr. Lyon, that I needed something to strengthen my "opinion that the foreign bodies were individuals of a parasitic organism." Finally, after numerous unsuccessful attempts, I have been able to culture the organism and thereby prove that it is a distinct being, and not some morbid cytoplasmic structure developed by unseen causes.

For a good general description of Fiji diseased plants the reader is referred to a paper by Reinking (3).

Fiji disease is not the only cane disease that has been attributed to plasmodial organisms. Matz (4, 5), working in Porto Rico, has described a plasmodial body present in many cells of cane showing yellow stripe disease; i. e., sugar cane mosaic. Frequently, in the parenchymatous tissues of leaves and stems of Fiji diseased cane I have observed cell contents that closely agree with the structures that he described as plasmodia. Careful examination with polariscopic and simple microchemical tests has convinced me that, in the case of Fiji diseased cane, such cell contents are carbohydrate waste products produced by and not the cause of the disease. Unfortunately the illustrations, that accompany the article alluded to, do not show the nuclear conditions of the cells wherein the

[1] Experiment Station Record No. 97.

plasmodia are forming. However, the author figures yellowed nuclei with thickened walls and calls attention to the fact that they simulate plasmal bodies. Such nuclei are abundant in the dying parts of Fiji diseased cane. He describes the suspicious plasmal content as "more or less hardened or compact, densely but finely granulated and slightly browned plasma". When pieces of diseased cane were stored for several days the plasmal masses were observed to have undergone certain changes. The granules became visibly more distinct and exhibited what he describes as a "rotary movement". He is not at all certain that this plasmal mass is the cause of the disease. He states: "furthermore this substance, resembling a *Plasmodium*, in some of the interior cells was found to be constantly associated with yellow-striped cane in an advanced stage of disease". That it really is a plasmodium remains to be proved.

Another plasmodial disease of cane is a vascular one. It was discovered and described by Matz (6). The original description of the causal organism is as follows:[2]

Plasmodiophora vascularum Matz. "The spores in their advanced stage in the interior of the vessels of the fibro-vascular bundles are spherical with smooth, somewhat thick hyaline walls, evenly granulated or sometimes coarsely granulated in the interior, orange, yellow, sometimes slightly brown in color, measuring .014–.016 millimeters in diameter. Spores are embedded in a yellowish, hyaline, at length hard matrix. Plasma is composed of a mass of granular cytoplasm, later developing into individuals composed of clear, cytoplasmic variable bodies having a dense, darker, granular center."

This description would answer for certain of the stages in the life history of the organism here described. He figures the organism as occurring in both the proto and the meta-xylem strands. The cane containing this organism was stunted, and the tops were either partially or totally dry. Perhaps what Mr. Matz described was but an early Fiji infection, since the description he gives of the disease is that of Fiji disease before the formation of the galls. However, the Fiji organism, although it invades the meta-xylem is seldom seen in the proto-xylem.

METHODS OF INVESTIGATION

In regard to the technique whereby the results here presented have been obtained the following may not be amiss. The making of really satisfactory paraffin sections of cane tissues, except the very young parts, involves the cutting of tissues that contain a great deal of silica. The technique used must be such that the tissues will either actually soften or have little chance to harden. No matter what fixative is used, the times in the higher alcohols should be very short. To show the general appearance of gall and leaf tissues, and especially cytoplasmic structures, a mixture of 6% formalin, 5% acetic acid in 50 per cent alcohol was most successful. In this fixative nuclei clear up but the plasmodia remain dark. Fleming's weaker solution for 30 minutes followed by a 1% chromo-acetic solution for 48 hours gives excellent fixation in the host nuclei but generally causes some plasmolysis. By means of this fixative I was able to demonstrate mitosis in the plasmodia. Long times in the chromo-acetic fixatives soften the tissues so that they can be cut. I tried following short fixation in chromic acid fixatives with a treatment of weak hydrofluoric acid but the cell contents were

[2] In the original description, the genus is spelled Plasmdiophora instead of Plasmodiophora; I presume it must be a typographical error.

mutilated. The plasmodial structures show up well in material fixed in a hot saturated solution of bichloride of mercury; Erlich's haematoxylin gave beautiful preparations after this fixative. Since many stages of the organism are less than a micron in diameter and the mature spores (cysts) are seldom more than seven microns in diameter little can be learned about their finer details with sections more than five microns in thickness. Unfortunately, the climate here in the Los Baños region is so constantly warm and moist that I have found it impossible to cut smooth serials thinner than three microns, and to do even this, it is necessary to use ice. Certain details of the spore wall anatomy will require one micron sections for the solving.

One of the simplest ways to clearly distinguish plasmodia from nuclei in free-hand sections is to put the sections in picro-nigrosin for one hour and then wash them and mount in water. The nuclei absorb the nigrosin much more readily than do the plasmodia. For demonstrating the finer details in paraffin sections, I have found Erlich's acid haematoxylin and Haidenhain's haematoxylin far superior to the aniline dyes including the triple combination. In studying the ameboid stages I used Giemsa's stain. When the galls are partially lignified beautiful preparations may be obtained by staining first in Erlich's and then in safranin. The plasmodia (amebae) may be sharply stained with Loefler's alkaline methylene blue, but this does not serve to differentiate the plasmodia from the nuclei.

It is very hard to get the organism to grow in drop cultures. The most successful culture I obtained was made as follows: A badly diseased plant was washed in 3 % cresol for a few seconds, then in sterile water, then cut with a sterile knife in such a way that the juice could be mashed out into a sterile petri dish. This juice was used for making hanging-drop cultures. In this particular set I prepared four slides. In the juice of each slide two or three extremely thin free-hand sections of large galls were placed. In *one* slide only the spore stage (cysts) germinated into active amebae as described below. Unfortunately the culture was contaminated and lived for only 34 hours. I first tried picking the spores out of sections with fine-drawn glass rods but have found the very thin section method preferable. My most successful cultures have been from sections whose thickness was from eight to ten microns in the gall tissue. My second most successful culture was obtained in a similar fashion but with healthy White Luzon cane juice. I have obtained numerous partially successful cultures in juice of both diseased and healthy cane. For some reason I have never obtained more than two really good cultures out of every hundred. Why, I do not know. I am certain that light is not a factor. I cannot demonstrate any definite relation to temperature. Contamination is not a factor. I have made both contaminated and pure cultures germinate.

The following procedures gave negative cultures: (1) Hanging-drop mounts in various dilute solutions of glucose. (2) Hanging-drop mounts in various dilute solutions of saccharose. (3) Hanging-drop mounts in mixtures of glucose and saccharose. (4) Hanging-drop mounts in mixtures of cane juice and sugar solutions. (5) Hanging-drop mounts in cane juice containing glands and mouth parts of certain sucking insect. This last is still being investigated.

CHARACTERISTICS OF THE ORGANISM

Before going into details regarding the life history and morphology of the organism, I wish to present the following as a summary of its characteristics.

In cane plants wherein the symptoms of Fiji disease are developing, the organism can first be demonstrated in the developing galls. In the cells of the developing galls they may be seen as irregularly shaped, lobed, ameboid bodies composed of granular protoplasm, the granules more or less equally distributed with little or no differentiation of ectoplasm. One to six such ameboid bodies are present in each cell; three is a very frequent number. These bodies differ greatly in size. One or more is generally attached to the host nucleus. The larger individuals in each cell may be seen to be pinching themselves into several smaller individuals or more frequently to be dividing into two equal halves. Stained preparations of this stage show that the bodies breaking up into smaller ones contain nuclei in a stage of chromidial fragmentation typical of amebae, and that the nucleus or nuclei are seldom or never organized within a nuclear membrane, but that when the larger individuals divide into equal halves they may do so by a primitive mitotic method. During this ameboid period the gall continues to develop, and as pointed out by Lyons divisions of the host nuclei accompany divisions of the organism. There are far more ameboid bodies than nuclei, yet every cell does not contain an ameboid body. There are, however, many more divisions of the organism than of the host nuclei, and I am certain that the divisions of the host nuclei are more frequently amitotic than mitotic. As the galls get older the bodies cease to divide. They cease to divide when the host begins to thicken the walls of the galls. Then the ameboid bodies begin to round up. All sizes round up, hence the various sizes of rounded bodies in the mature galls. Until this rounding up gets well under way, one or more of the bodies in each cell remain attached to the host nucleus. But the host nuclei may disintegrate as the organism goes into its mature stages. Seldom are mature organisms—spores—attached to nuclei. When the ameboid bodies begin to round up they begin to differentiate vacuoles in their cytoplasm. The finished structure is a hollow shell composed of highly vacuolate material, the whole constituting a firm but not brittle wall; the central portion is a clear hydro-gel. These spore bodies (cysts) are so firm that they may be readily extricated from thin sections and examined separately. When mashed with a finely drawn glass needle they quickly rebound to their original shape. These spore bodies are not formed by the cleavage of a larger plasmodial body; the larger amebae form smaller ones and either the larger or the smaller change into spores. Such bodies are not true spores; I here propose to call them *cysts*. Plants having mature galls and mature cysts exhibit dwarfing and other features of Fiji disease. In such plants it is not difficult to demonstrate various forms of the organism in other parts of the plant. Partially encysted stages may be occasionally found in the metaxylem; I have found them in the metaxylem of the roots. Such plants have very typical reduced root systems. In swollen places on these roots, which are really galls, the organism often occurs in abundance. When germinating, these cysts simply soften up their walls, generally irregularly, so that parts lobe out like a moving *Arcella*, then by

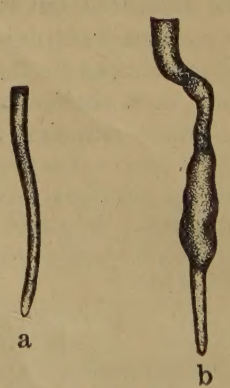

FIGURE 1.
Roots of Sugar Cane
a—Normal Root
b—Fiji gall on root

rearranging the granules composing the walls of the individuals vacuoles, change themselves into typical motile amebae. Each ameba develops one or more slowly contractile vacuoles. Both rounded and pointed pseudopodia are developed. The pointed pseudopodia which the organism develops in culture, are the nearest thing to flagellate or ciliate organs of motion that I have seen the organism exhibit. The ameboid stage in cultures shows little ectoplasmic differentiation, but in all there is a distinct, highly refractile mass present that looks and behaves like a nucleus. In cultures, the organisms that develop from the large cysts differ little from the smaller ones. However, the smaller ones, when dividing, frequently go through a peculiar trypanosome like shape. Summing this up, the cycle is ameba—cyst—ameba. During the rest of this paper I shall call them not "bodies" but amebae.

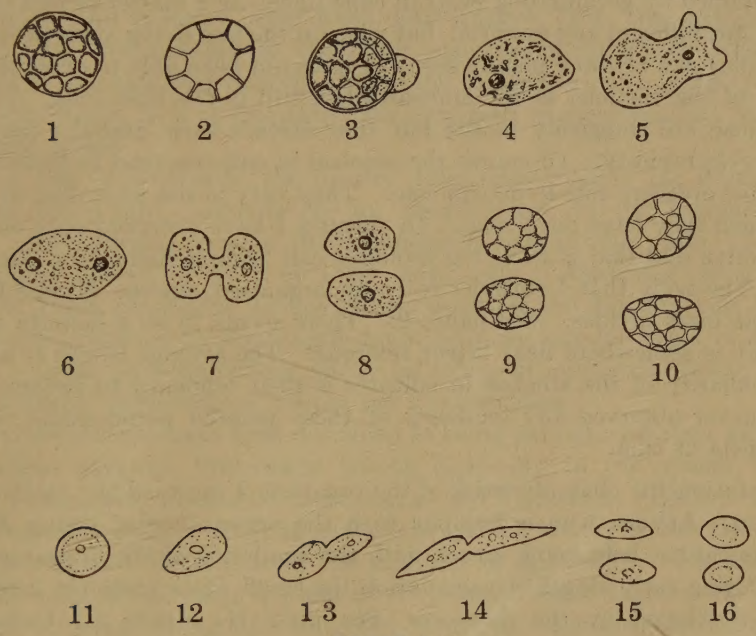

FIGURE 2.

1 Surface view of cyst. 2 Optical section of cyst shown in 1. 3 cyst germinating. 4, 5, 6, free amebae as seen in cultures. 7 ameba dividing; from culture. 8, 9, 10 Encystment as seen in tissues. 1-10 represent life cycle of large ameba. 11-16 represent life cycle of small ameba. 14 Peculiar *Trypanosome* like shape of small ameba in state of division.

Concerning the amebae in the cells the following may be of interest. In unstained sections it is difficult and often impossible to distinguish the amebae from the host nuclei. Fortunately the host nuclei frequently have plasmosomes which are plainly visible with an oil immersion lens of high N. A. even when examined in an unstained condition. The nuclei in the galls are a few microns larger than the nuclei of healthy parenchymatous cells. Metaplasmic granules and tiny starch grains present in both healthy and gall tissues will dance with a conspicuous Brownian movement suggestive of zoospores, if the sections examined are mounted in water. There is no excuse for making the mistake of calling them zoospores for such zoospore-like bodies are more abundant in healthy than in gall tissues and if either are mounted in their own juice little or no Brownian

movement will take place. Another thing that can be confusing in studying the nature of this ameboid stage, is the ability of normal cane nuclei to move around. I have frequently observed the nuclei of healthy cane parenchyme cells mounted in water or juice to change form and position and move about their alveolar contents. From nuclei the unstained amebae differ, also, in having a more even distribution of their granular content. In only one culture of the many that I have attempted of the organism at this stage have I been able to make these amebae leave the gall tissue and climb out of the host cells into the juice in which they were mounted. It took sixteen hours to accomplish this; after they came out of the cells they soon lost their activity. No movement whatever was observed after 18 hours.

The amebae present in the developing gall tissues differ but little from cultures obtained by germinating cysts in cane juice. As a matter of fact they probably do not differ in any essential, but when in the free living state provided by a culture they can be more plainly seen. I have not been able to observe any contraction of the vacuoles in the amebae when still in the host cells. In cultures the amebae are sluggishly motile but they stream their granules around with considerable rapidity. Of course the amebae in cultures tend to flatten out and spread like ordinary free-living amebae. They vary in size according to the cysts from which they have developed. In cultures I have observed only one kind of reproduction and that is what the zoologist call "simple fission" or "simple division". The body that I consider to be an organized nucleus divides first; then the whole mass divides. See figure 2. There seems to be a definite size limit; this limit is somewhere near fifteen microns. The average length is about five. One peculiarity of the amebae in cultures is their tendency to become pointed. I have never observed any tendency of these pointed pseudopodia to develop into flagella or cilia.

In stating the characteristics of the organism I outlined the method of cyst formation. Anyone who is familiar with the appearance of young *Entamoeba coli* cysts cannot help being struck with the similarity of the appearance of the two. During early stages of vacuolation the small cysts resemble certain "ring stages" developed by the *Sporozoa*. See plate II, Figure 1. Unfortunately the cysts stain so homogeneously that it is very hard to make out nuclear conditions in them. Until I have had a chance to study good one or two micron sections I do not wish to make any definite statement about this point. Some of my Erlich's haematoxylin preparations show indications of nuclear material in the larger vacuole walls; this would suggest that such cysts would on germinating break up into several individuals. I have seen no hint of such a process of reproduction in living material. Since each cyst changes into one ameba only, and since each ameba has only one nucleus, it is likely that the cysts are uninucleate. Although the wall of the cyst must contain much metaplasm I have never seen any attempt on the part of the organism to shed the wall when it germinates; the wall becomes part of the motile ameba's protoplasm.

As I have indicated, reproduction is accomplished by gemmation and simple fission. That is, the large plasmodia containing fragmented nuclei bud off on several sides into small masses, each equipped with sufficient chromatin material to enable it to develop into individual amebae. This process is hard to see in unstained material but can readily be seen in stained. When a large ameba

divides into two equal halves it may do so by promitosis as shown in Plate II, fig. 15. I have seen no indications that the large amebae are able to cleave into a mass of spores more or less alike in size and more or less loosely connected. The spore-like cysts differ greatly in size. Each cyst is formed from a single ameba, and since the amebae differ in size, so do the cysts. These cysts represent a resting, nonmotile stage in the life history of the organism and cannot be considered a method of reproduction. Each cyst changes into only one ameba.

CLASSIFICATION OF THE ORGANISM

The characters here presented as describing the organism are obviously more animal than plant. To put it in the genus *Plasmodiophora* is out of the question. Its amebae show no tendency to coalesce into a true plasmodium, the spores are large, vary in size, absorb their membranes when germinating, have no zoospore stage, and in many other ways differ entirely from this genus. They have little more resemblance to the other members of the *Plasmodiophorales*. I am forced to conclude that the organism in the Fiji galls is an ameba, parasitic not on animal tissue, as is so frequently the case with tropical amebae, but parasitic on plant tissue.

Among the *Chytridiaceae*, the fungus *Asterocystis radicis* De Wild., which causes flax root-blight, presents certain resemblances to the organism here described. This fungus lives in the dermatogen cells of the roots. Its plasmodial bodies fill all or part of their host cells. According to available descriptions, these plasmodia do not closely resemble the Fiji amebae, but the resting spores produced by the fungus might be mistaken for cysts of the Fiji organism. *Asterocystis* reproduces chiefly by means of numerous swarm spores, which fact clearly differentiates it from the Fiji organism.

Several protozoans have been described as being parasitic on algae and water plants. These parasitic Protozoans belong especially to the genera *Vampyrellidium*, *Vampyrella*, *Ectobiella*, *Enteromyxa*, and *Colpodella*. All are members of the Proteomyxa group. But the characters and life history of the Fiji amebae are simpler than and different from the members of this group. The characteristics of the amebae and their method of encystment relate them to the Lobosa group of the *Protozoa*. I can find no record of such an organism functioning as a plant pathogen. The Fiji ameba resembles *Entamoeba coli*, but the behavior of its nuclei and germination of its cysts serve to distinguish it from that genus. It cannot be classed under any of the free living genera such as *Amoeba*, *Paramoeba*, *Centrochlamys*, *Pelomyxa*, *Dactylosphaera*, etc.

Whether or not the Fiji organism should be classed with *Proteomyxa* or *Lobosa* I shall leave for some proto-zoologist to decide, but since there is apparently no existing genus wherein it may be placed I propose the following as a generic name on the basis that the organism is an ameba somewhat related to *Entamoeba*. Since Lyon did not publish his paper wherein he proposed the name *Northiella sacchari* for the "body" and does not imply any wish to so call it in his 1921 paper, I can hardly cite that name as a synonym. It looks like am ameba and lives in a plant, so I propose the generic name *Phytamoeba*, instead of *Northiella*, as the latter name has no biological significance. For species, the name *sacchari*, as suggested by Lyons, is certainly appropriate. Descriptions follow:

Phytamoeba g. nov. Small intracellular amebae capable of living in a free state. Little differentiation of ectoplasm. Pseudopodia lobose, blunt. Repro-

duction by gemmation and simple fission. Cysts form in host cell. Each cyst develops into one ameba. No zoospores.

Phytamoeba sacchari sp. nov. Small intracellular, parasitic ameba capable of living in free state. Size variable, seldom more than 12 *u*. When intracellular, pseudopodia are short, blunt, and lobose; when extracellular pseudopodia are lobose or pointed. Vacuoles present, more or less contractile in extracellular type. Nucleus organized or distributed. Cysts simple, rounded, highly vacuolate, walls smooth. Cysts germinate into amebae. Reproduction by gemmation and simple fission. No zoospores. No coalescing of amebae to form large plasmodia. Host, *Saccharum officinarum* Linn.

RELATION OF PHYTAMOEBA TO FIJI DISEASE

That Fiji disease is actually caused by *Phytamoeba sacchari* cannot be considered demonstrated until pure cultures of the organism injected into healthy cane produce the disease under controlled conditions. At present I have a number of such experiments in progress, but it will be several months yet before the results will be available. The evidence that the organism is the cause of the disease is as follows. When the disease first appears the organism in some stage or other is always present in the developing galls. It is abundant only in the galls and cannot be demonstrated in healthy plants. In the first stages of the disease, galls are produced only on the leaves. In the later stages, the galls occasionally develop on the roots. They are abundant in the lower internodes of dying branch shoots; these internal galls (if so they may be termed) appear as grey spots up to one millimeter in diameter. In both roots and internal galls the organism is abundantly present. This means that the organism lives throughout the plant, which would account for the fact that when any node of a diseased plant is used as seed, Fiji disease results. (7, 8.)

With regard to the path of the organism through the cane plant I wish to withhold my data for future publication. I have evidence that the organism passes partly through the metaxylem and partly through certain cells of the pericycle lying between the xylem and phloem. This would help to account for the fact that the galls generally develop from that region of the pericycle.

The important question as to how the disease is carried remains undemonstrated. That it is insect borne, I have little doubt. If it is insect borne, in what condition does the organism live in the mouth or salivary glands of the insect?

SUMMARY

The "plasmodial body" present in the cells of Fiji galls is an ameba having many of the characters of *Entamoeba*. The name here proposed for the organism is *Phytamoeba sacchari*.

The organism can be cultured in cane juice. It was hoped that its ability to grow in the juices of different cane varieties could be used as a test for the susceptibility of the varieties to Fiji disease. Unfortunately the organism is so hard to grow that this method of testing proved impractiacble.

ACKNOWLEDGEMENT

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ILLUSTRATIONS

Plate I

Fig. 1.—Large parenchymatous cell from healthy leaf tissue as seen in unstained sections. For details of nucleus see fig. 2. The circular bodies are tiny starch grains floating free in the cytoplasm; similar bodies showing Brownian movement in the gall cells might be mistaken for zoospores.

Fig. 2.—Diagrammatic sketch of normal nucleus shown in fig. 1. P; plasmosome. S; vacuolar space around plasmosome. G; granules and droplets characteristics of such nuclei. apx. 5000 x.

Fig. 3.—Nucleus (dark curved body) and three cysts. Picro-nigrosin preparation.

Fig. 4.—Nucleus and two amebae. Large ameba appears to be getting ready to encyst. Unstained.

Fig. 5.—Large ameba in cell. Nucleus not shown. When in this condition it is very hard to distinguish ameboid nuclei from the *Phytamoeba* organism.

Fig. 6.—One ameba and two young cysts; nucleus not shown.

Fig. 7.—Old gall cells with thickened walls. Drawing shows surface view of mature cysts. Plasmosome plainly differentiates cell nucleus from cyst. Reticulate body in cell containing three cysts is also a nucleus. Erlich's haematoxylin preparation.

Fig. 8.—Space picture of young cyst within thickened outer gall cell.

Plate II

Fig. 1.—Gall cell beginning to thicken. Young cyst attached to wall cell. Nucleus not shown. Note vacuoles in cyst wall and nucleus like body in center of cyst. Iron haematoxylin preparation.

Fig. 2.—Young gall cell, walls unthickened, containing nucleus in resting condition and ameba in process of gemmation. Note the well defined plasmosome in the cell nucleus. Erlich's haematoxylin preparation.

Fig. 3.—This is a sketch of the ameba shown in fig. 2.

Figs. 4-9.—Optical sections of living cysts to show method of vacuolation. Surface views of cysts in condition shown in figs. 8 and 9 are illustrated in Plate 1, figs. 3 and 7. Illustrations 4 and 9 drawn by focussing central plane of cysts with short focus fluorite lens and sketching image projected with 6 x compensating eyepiece through camera.

Figs. 10 and 11.—Camera lucida drawing of germinating cysts. Surface views.

Fig. 12.—Ameba from cyst. Vacuole forming. From culture.

Fig. 13.—Ameba in peculiar pointed condition. No vacuole. From culture.

Fig. 14.—Ameba apparently about to divide. Note that two nucleus like bodies are present.

Fig. 15.—Ameba in gall cell with nucleus in late phase of division. Body next to ameba appears to be a cell nucleus disorganizing.

Fig. 16.—Ameba typical of form that develops from small cyst.

All figures, unless otherwise indicated, were drawn with 1.32 N. A. fluorite lens, and 6 x compensating eyepiece. Large Spencer camera, 160 mm. setting. Initial projection 1230 diameters; all figures reduced apx. 1/3 in making plates.

PLATE I.

PLATE II.

SOME CESTODES FROM DOMESTIC ANIMALS IN THE PHILIPPINE ISLANDS THAT ARE OF ECONOMIC AND HYGIENIC IMPORTANCE

By Benjamin Schwartz[1]

Of the College of Veterinary Science

The object of this paper is to record the presence of cestodes and cestode diseases that I have thus far encountered in domestic animals in the Philippine Islands. The records are based on post-mortem findings in the clinic of the College of Veterinary Science, in the Azcarraga abattoir in Manila, and, as noted elsewhere in this paper, on specimens received from some of my associates in the University of the Philippines.

Many more species than those recorded in this paper doubtlessly occur in the Philippines. Systematic autopsies will probably reveal many additional forms, at least the more common species of cestodes that are known to occur in domestic animals in other parts of the world, and that are not included in the following pages.

MEASLES IN CATTLE AND SWINE

As used in veterinary medicine, the term "measles" refers to pathological conditions primarily in cattle and swine, due to the presence in the musculature of these animals of bladderworms or tapeworm cysts, the adult forms of which are strobilate tapeworms that occur in the small intestine of man. Two species of Taenia from man, namely *Taenia solium* and *Taenia saginata*, have been recorded from the native population in the course of various helminthological surveys, the source of infection with these parasites being "measly" pork and "measly" beef, respectively.

BEEF MEASLES (CYSTICERCUS BOVIS)

Beef measles is a pathological condition in cattle due to the presence of *Cysticercus bovis*, the larval stage of *Taenia saginata*, in the musculature of these animals. So far as I know, this parasite has not been reported from native cattle. In a former paper (1) I called attention to the fact that the records of the Bureau of Agriculture show that imported cattle from French Indo-China that are slaughtered in Manila are remarkably free from *Cysticercus bovis* infection because only two cases of infestation with this parasite have been found in about thirty thousand animals that were examined during a period of six years. The occurrence of *Cysticercus bovis* in native cattle, though not definitely recorded, may be taken for granted, however, in view of the fact that the adult form, *Taenia saginata*, has been recorded from time to time in inhabitants of the provinces, many of whom must have acquired the infection from native beef.

Cysticercus bovis occurs in various muscles, notably the heart, the muscles of mastication, the diaphragm and the tongue. The presence of these parasites may be discovered by thoroughly inspecting cattle carcasses that are intended for human consumption.

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[1] Experiment Station Contribution No. 98.

Man becomes infested with the adult tapeworm as a result of swallowing raw or insufficiently cooked measly beef. From the viewpoint of meat inspection, carcasses that are heavily infested with *Cysticercus bovis* and carcasses that show a moderate or even light but generalized infestation with this parasite are unfit for human consumption and should be condemned. Slightly infested carcasses may be passed for food after all the visible cysts have been removed, but the meat from such carcasses must be thoroughly cooked, as many cysticerci may escape detection. According to Ransom (2) infested carcasses may also be rendered innocuous by refrigeration or pickling for a period of three weeks.

Since cattle become infested with *Cysticercus bovis* as a result of swallowing the shelled embryos of *Taenia saginata* that are expelled from the human host with the feces, the prevention of measles in bovines is dependent upon the proper disposal of human feces. The placing of human feces where live stock may have access to it, or where it may contaminate feed or water of live stock, favors the perpetuation of measles in cattle and thus renders man liable to infection with the adult tapeworm.

An efficient system of meat inspection will, of course, do much to eradicate this parasite. In the Philippines, however, meat inspection is practically nonexistent outside of Manila and the chief emphasis must be placed therefore on thorough cooking of meat and on the proper disposal of human feces. The latter precaution will also aid in eradicating other intestinal borne diseases, such as typhoid, dysentery, cholera, etc.

PORK MEASLES (CYSTICERCUS CELLULOSAE)

Pork measles is a pathological condition in hogs due to the presence of *Cysticercus cellulosae*, the larval stage of *Taenia solium*, in the musculature of these animals. These parasites are of rather common occurrence in native swine. The records for Manila for a period of six years during which period nearly six hundred thousand hogs were slaughtered, show that from one to one and a half per cent of these animals are infested with *Cysticercus cellulosae*. The detailed records have been published elsewhere (1).

Cysticercus cellulosae occurs principally in the tongue, the muscles of mastication, and the muscles of the shoulder and of the neck and in the diaphragm. The parasites may be detected by meat inspectors in the course of routine examination of hog carcasses.

Man becomes infested with *Taenia solium* as a result of swallowing insufficiently cooked measly pork. Swine acquire the infection with cysticerci as a result of swallowing the shelled embryos that are eliminated with the feces of human beings harboring *Taenia solium*.

Heavily infested hog carcasses should be excluded from human consumption altogether and lightly infested pork should be thoroughly cooked before being eaten. In this connection it should be remembered that a person that harbors *Taenia solium* may also become infected with the larval stage of the parasite as a result of contaminating his hands with his own feces, and thereby contaminating his food, or he may become infected in some other way. In man the cysticerci may lodge in the muscles, in the eye, in the brain and in other organs.

In view of the avidity with which hogs devour human feces, heavy infections of measles is much more common in hogs than in cattle. The recommendations concerning the proper disposal of human feces in order to prevent measles in cattle apply with even greater force to the eradication of measles in hogs.

From economic and hygienic viewpoints *Cysticercus bovis* and *Cysticercus cellulosae* are the most important cestodes in domestic animals, because carcasses that are heavily infested with these bladderworms are generally unfit for human consumption, thus causing a distinct economic loss, and because these cysticerci are the intermediate stages of tapeworms that commonly occur in man.

HYDATID DISEASE (ECHINOCOCCUS)

The term hydatid disease is applied to pathological conditions in cattle, sheep and swine due to infestation with the larval stage of a tapeworm, the adult form of which occurs in the intestine of dogs, and is known as *Echinococcus granulosus*. The cysts, which may attain considerable size usually occur in the liver and lungs, but may occur in any organ. The larval stage also occurs in man, causing a serious, and often fatal disease, but infestation with this parasite is comparatively rare in human beings.

Wharton (3) states that several cases of infection of man with the larvae of Echinococcus have been recorded in the Philippines and he also states that he has been unable to find any authentic records of the occurrence of the adult tapeworm in native dogs. I have examined over fifty native dogs and I have not found *Echinococcus* in these animals.

So far as concerns the occurrence of the larval stage of *Echinococcus* in domestic animals in the Philippine Islands, I am able to report two cases from cattle through the courtesy of Dr. A. K. Gomez, who placed the material at my disposal. In one case a cyst was found in the heart of a cow that was autopsied in the College of Agriculture at Los Baños, and in the second case cysts were found in the lungs of an Indian buffalo autopsied in Manila.

CYSTICERCUS TENUICOLLIS

Cysticercus tenuicollis is a larval tapeworm that occurs in the abdominal cavity of cattle, sheep and hogs. The bladderworms are usually attached to the mesenteries and to the omentum. The adult stage of this cestode occurs in the intestine of dogs and related carnivores.

I have been able to examine several specimens of *Cysticercus tenuicollis* from hogs from the province of Pampanga, through the courtesy of Dr. M. A. Tubangui.

Thus far, the adult tapeworm (*Taenia hydatigena*) has not been recorded from native dogs, but the occurrence of this parasite in these animals may be inferred from the occurrence of the larval forms in hogs.

TAENIA TAENIAEFORMIS

In view of the fact that no tapeworms belonging to the genus *Taenia* have been recorded heretofore from carnivores, namely dogs and cats, in the Philippines, it may be of interest in this connection to note the occurrence of *Taenia taeniaeformis* in native cats. These parasites, though by no means very common, have been found in the intestine of cats by the writer and his students. The larval stage of this parasite, *Cysticercus fasciolaris*, is of common occurrence in house rats and in field rats, as well as in mice in the vicinity of Los Baños.

MONIEZIA EXPANSA

Through the courtesy of Dean C. F. Baker I secured a single specimen of *Moniezia expansa* from cattle in Mindanao.

MONIEZIA TRIGNOPHORA

Several specimens of *Moniezia trignophora* were collected from the intestines of native sheep at the Azcarraga abattoir, Manila. This parasite is not of very common occurrence in sheep that are slaughtered in Manila.

ANAPLOCEPHALA

Two species of Anaplocephala, namely *Anaplocephala perfoliata* and *Anaplocephala mamillana* occur in native horses, the former species being very common. I have collected these parasites from the intestine, colon and caecum of horses killed in the clinic of the College of Veterinary Science.

HYMENOLEPIS

In view of the fact that two species of Hymenolepis of common occurrence in rats also occur in human beings, it is of interest to note that rats trapped on the college grounds at Los Baños are nearly always parasitized with *Hymenolepis diminuta* and *Hymenolepis nana*, species that have been recorded from the native population.

DIPYLIDIUM

Dipylidium caninum is of common occurrence in native dogs. Species of Dipylidium are also very common in native cats.

Dipylidium caninum has also been recorded from human beings, and a note on its occurrence in a Filipino child was published by Mendoza-Guazon (4).

DIPHYLLOBOTHRIUM

I have received specimens of cestodes from dogs belonging to the genus of *Diphyllobothrium* from a veterinary hospital in Manila. These parasites are not very common, but they are by no means rare in native dogs. I have not found any cases of infestation with these parasites in dogs or cats in the course of my autopsy work on these animals. Wharton (3) reports, however, the occurrence of Diphyllobothrium in native dogs and cats and states that these parasites are very common in the latter host.

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IMPROVEMENT OF THE LANZON (*Lansium domesticum* Jack)

By Nemesio B. Mendiola[1]
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ONE PLATE

In the order of importance, the problems in lanzon breeding are: (a) Multiplication of the sweetest varieties, (b) multiplication of the varieties producing a small percentage of seeded fruits and the search and propagation of seedless varieties or bud mutations, (c) the elimination of the milky juice of the rind and the bitter taste of the covering of the seed, (d) elimination of the "rags", or the loose tissues lying at the center of the fruit and between the fruit segments, and (e) the production of better yielding strains. The first four concern the consumer more than they do the grower. The lanzon is on the market for a brief season and there has never been a serious oversupply so that the consumer buys whatever is offered him. He may discriminate against small size or sour fruits, when larger and sweeter kinds may be had, if not, he buys anyway what is sold. If the grower could offer him improved fruits, he may be sure to get a better price. From the grower's standpoint, the last problem, that of yield, is probably the most important. If he could increase his output of fruits even without improvement in quality, he is bound to get more profit as there is always a demand for the fruits. At times the lanzon sells cheap in Manila and in its immediate vicinities and it would seem then that the market is glutted. This seems to be the case during the height of the lanzon season. Undoubtedly, a wider sale of the fruit in the Philippines, which is bound to increase as transportation facilities are increased, will for a long time to come take care of any increase in production which the growers may be able to make.

METHODS OF IMPROVEMENT

Each owner of lanzon plantations is probably more or less familiar with his trees. If a close friend approaches him for an order of special fruits for purposes of a present, "regalo", to a third party, the owner tells immediately from what tree the fruits should be gathered. If the tree indicated is without ripe fruits then or has an insufficient number of ripe fruits, he points to a second or a third tree. The question of variability and location of desirable trees is then more or less settled as far as each owner and his own trees are concerned. The problem is to propagate the desirable trees. Probably the grower gets his seeds for his own use from the trees which he considers most desirable. Whether or not the plants which he gets from these seeds come true to type is not known and it seems that this is an essential question for the lanzon breeder to study. Meanwhile it may be assumed that lanzon seedlings are more or less variable in regard to many of their important characters. If the lanzon could be propagated in a large scale by vegetative means, the question will dwindle in importance for by such method of propagation, seminal variability is practically avoided. At present, however, the lanzon is propagated by native growers practically by seed only. Since the

[1] Experiment Station contribution No. 99.

lanzon may be marcottaged, a method already practiced successfully by the growers of the chico, or the sapodilla, and one that is simple, efforts should be made by the extension elements of the Government to encourage growers to propagate their best and most productive trees by marcottaging while at the same time they are distributing grafted plants.

The College of Agriculture and specially the Bureau of Agriculture distribute lanzon seedlings. There is here a chance to introduce gradual improvement. Instead of distributing seedlings without regard to parentage, only seedlings from known desirable parent trees, selected on the basis of the problems of improvement already mentioned, should be distributed to prospective planters. What is better, scions from selected trees and grafted on seedlings, may be distributed in a larger scale than it is done at present.

The lanzon plantations in the Philippines should be surveyed, as fast as facilities will allow, for their plant breeding possibilities. The survey should include not only a comparative study of individual trees but also a study of bud variations within the tree. It is known for example that certain trees bear mostly seedless fruits. It is not impossible that some parts of these trees are bud sports as to seedlessness.

The survey could be done without much expense. During the season, tree owners "let" their plantations to what may be termed middlemen who pay a certain sum to the owner as payment of the fruits. The middleman then takes care of the harvesting and the sale of the harvest. In this way he often gets a fair profit. Should the Government undertake a thorough survey for desirable trees it can do the same as the middleman,—rent the trees and study them also, except that it has to open some fruits in the study. The rest of the fruits may be sold.

VARIABILITY

Fruit.—It is commonly known that as to sweetness there are at least two varieties of fruits,—the sweet and the sour. A middle class is also found, one which is neither sweet nor sour. The lanzon from Paete, Laguna, is reported to be generally of the sweetest variety. Growers of San Pablo, Laguna, however, make strong claims that the San Pablo lanzon is no less sweet, and that if it is sour, it is merely due to the fact that it is not allowed to ripen fully before it is picked. As to shape of fruit, two varieties are recognized. These are the round and the elongated. The elongated is generally, if not always, a sweet variety also. Sweetness is usually indicated by a blackish area at the end of the fruit around the stem, due to infection by mildew. The correlation is so well established that even little children can pick the sweet fruits in a mixture on the basis of this association of characters. Aside from these types, there are also the fully seeded fruits, those with only one segment bearing seed and those practically seedless. Dean Baker says he was told by Mr. Wester, of the Bureau of Agriculture, that there are trees known which are producing all seedless fruits from year to year.

Types of trees.—The question which immediately arises is whether the trees may be classified on the basis of the variability found in the fruit. Are round and elongated or sweet and sour fruits borne in the same tree?

In an attempt to find an answer to these and related questions, a study was made of the variability in a number of characters including those which decide

the commercial value of the lanzon fruit. This study was made by the Division of Genetics, in 1919, and previously in 1915, under Professor Baker. The 1919 study performed by Mr. Simeon Panganiban under the immediate direction and supervision of the author covered the towns of Nagcarlang, Pacte, Alaminos, San Pablo, and Lilio, Laguna Province. It must be remarked, however, that the lanzon is also grown in other provinces specially in those belonging to the Visayan and Moro regions.

As a result of the 1919 study, six distinct types of trees, distinguished according to fruit characteristics specially, were discovered. These types may be described briefly:

Type 1.—Fruits are irregularly ellipsoid, generally large, seedy, and of poor flavor and quality. The branches of the tree are spreading, a characteristic which is not common.

Type 2.—Fruits are roundish to ellipsoid, very small to medium in size, seedy, of poor flavor and quality, and fruits in bunch do not mature uniformly.

Type 3.—Fruits are obovate or obconical borne very crowded in the bunch, medium in size and of good flavor.

Type 4.—Fruits regularly obovoid, small to medium in size, characterized by a high degree of seedlessness (77 per cent of fruits may be seedless), of excellent quality, a heavy yielder, sometimes fruiting two times a year.

Type 5.—This is the most common type. Fruits ellipsoid, variable in size, medium size predominating, seedy and fair in flavor.

Type 6.—Fruits ellipsoid to ovoid, medium to large in size, fair in quality, ripens uniformly in the bunch and trees may bear twice a year.

Some of the more important and detailed characteristics of the different types are shown in Table I.

TABLE I.—*Fruit and seed characters of different types of lanzon.*

Type number.	Fruit dimensions.	Av. wt. of fruit.	Seed dimensions.
	cm.	*gm.*	*cm.*
1	4.4×3.5	28.5	1.6×1.1
2	3.6×3.0	17.6	1.5×1.0
3	4.0×3.2	24.6	1.4×0.9
4	3.4×2.7	18.3	1.4×1.0
5	3.9×3.1	22.0	1.4×1.0
6	4.3×3.3	24.2	1.4×1.0

The characteristics of the different types regarding yield; flowering, fruiting and ripening; and eating qualities are given in Tables II, III and IV respectively.

TABLE II.—*Yield and age of each of six trees of each type in "kaing," or crate.*

Type.		Trees.						Average.
		1	*2*	*3*	*4*	*5*	*6*	
1	Yield in crates...	1.1	1.5	1.9	1.4	2.6	1.5	1.7
	Age in years.....	45	45	35	40	35	30	
2	Yield in crates...	1.7	2.0	2.5	1.6	1.7	2.5	2.0
	Age in years.....	50	45	55	45	37	50	
3	Yield in crates...	2.3	2.7	1.9	2.5	3.0	2.7	2.5
	Age in year.....	35	45	50	55	45	55	
4	Yield in crates...	2.8	3.0	3.5	2.5	2.2	3.7	2.9
	Age in year.....	50	55	45	40	35	55	
5	Yield in crates...	1.2	2.0	1.8	1.5	2.3	1.0	1.6
	Age in years.....	35	45	40	50	55	27	
6	Yield in crates...	2.5	2.0	2.5	2.7	1.8	3.0	2.4
	Age in years.....	45	50	55	40	35	45	

TABLE III.—*Flowering, fruiting and ripening in 1919.*

Type.	Date flowered.	Date fruited.	Date ripened.
1	June 20	August 3	October 30
2	June 20	August 3	November 9
3	June 20	August 3	October 30
4	June 30	August 3	November 9
5	June 20	August 3	October 30
6	June 20	August 3	October 30

TABLE IV.—*Flavor, quality and seed characteristic.*

Type.	Flavor.	Quality.	Seed.
1	faintly acid	poor	large seeded
2	very poor	very poor	seedy
3	good	good	less seedy than type 2
4	excellent	excellent	77 per cent seedless
5	sweet	good	
6	sweet	fair	

Previously, De Leon (1) reported practically the same six types.

Of the above types, No. 3 and No. 4 are very desirable for multiplication, and those interested should follow this work up and try to obtain seeds or vegetative parts of these trees for propagation. Types Nos. 1, 2, 3 and 4 were found in the plantation of Mr. Mariano Noble in barrio Ibabang Sungi, Lilio, Laguna. Type No. 4 was also represented by trees owned by Mrs. Luisa of Sta. Cruz, Laguna, and in 1919 in charge of Mr. Pedro Pondiga, barrio Calumpang, Nagcarlang, Laguna. Trees of Type No. 5 were found in the plantation of Mr. Esteban Villarin, Paete, Laguna, and of Mr. Vicente Buenaseda, Ibabang Sungi, Lilio, Laguna. Trees of No. 6 were found in the lot of Mr. Santiago de la Peña, Ibabang Sungi, Lilio, Laguna.

It is not known at present if those types are able to reproduce their forms by seeds.

Factors which may cloud hereditary variability.—In plantations, like those in the Philippines, in which the trees are not placed at regular distances, it may be necessary in a comparative study of trees to omit those which are conspicuously at an advantage as to space. Other factors in a plantation which may cause some trees to be apparently, even if not truly, better than other trees, are slight shade, and better soil, which is believed to be clay loam with fair drainage.

SOME IMPORTANT ENEMIES

It is to be regretted that a number of known desirable trees have died or are soon to die due to the effect of parasitism of the Loranthus. It is to be wondered why the owners of the lanzon trees do not take early steps to kill this parasite to save their trees. Another serious cause of the death of lanzon trees is apparently an attack by some weevil on the bark, causing gradual death of the branches and ultimately of the whole tree. An example of a tree thus affected is found near the residence of the manager of the Hacienda Calauang. The writer accompanied Dr. Uichanco, of the Entomology Department of this College, to the place for the purpose of studying the pest. Insects living in or below the bark were collected and undoubtedly a study of these specimens is underway. Professor Raymundo, of the Agronomy Department, claims that in Pila his lanzon trees once suffered from a similar if not identical trouble and that an effective control which he discovered, and possibly practiced by other lanzon owners, is to merely clean the trunk and branches using the ordinary native broom. The Departments of Botany and Entomology should find in these two serious enemies of the lanzon an inviting field of investigations along very practical and immediate lines.

ASEXUAL PROPAGATION OF THE LANZON

For those who may want to hybridize lanzon or propagate it asexually, it is necessary to remark that fifteen trials to root cuttings made in this College failed. Several hard wood cuttings calloused but none made roots. Marcottaging, however, was successful, the rooting in this case requiring about 134 days from the time of setting. It is said that plants produced by Chinese layering, or air layering, come to bearing earlier than those propagated by seeds, the plants grown from the latter producing fruits not earlier than 12 to 15 years of age. A distinct advance in the vegetative propagation of lanzon has been made by the Bureau of Agriculture. Wester (2) recommends cleft or side grafting, and the use of well matured, but not of old growth, scion which is preferably

6-8 centimeters long, about a centimeter in diameter and inserting it in a stock 6-10 centimeters above ground. Mr. S. Capistrano, in charge of the Singalong Experiment Station, and his assistant, Mr. I. Victorio, have also demonstrated that grafting may be done easily with lanzon. The trunk of the stock used has a diameter of about one centimeter or more and it is said that about 70 per cent success is obtained. Trials of budding have been practical failures. Because seedlings of santol, *Sandoricum koetjape* (Burm. f.) Merr., which belongs to the same family as the lanzon, may be grown very easily in abundance, attempts were made to graft lanzon on seedlings of this species. No success, however, has yet been obtained, but the thing is not considered at present as impossible. The trials were made during the hot season and it is suspected that too much heat was one of the factors which contributed to the failure of the scion to set. This work is wrapped up with great possibilities as santol seedlings are produced even naturally in great numbers, while lanzon seedlings are very slow growing and very difficult to grow.

SEARCHING FOR SEEDLESS BUD MUTATIONS

Correlation between degree of seediness and shape of fruit.—This lanzon season, the Division of Genetics has made the beginning of a direct attempt to discover seedless bud mutations. This work is partly being carried out by Mr. J. Pagsolingan, a senior student, and consists in going to those plantations in which highly seedless forms are known to exist, and sampling the branches of individual trees. Trees in other, previously unexamined plantations are also studied. As soon as a fruit in a given bunch of a branch is found with even a single seed, the test is considered sufficient to demonstrate that the branch in question was not a seedless bud mutation.

In this method of sampling, the sample fruit is opened. For this reason, the method is more or less expensive and it becomes necessary to have a less expensive one.

It is believed one such method has been discovered which consists in using a particular shape of the fruit as an index of entire seedlessness. It has been found that any asymmetry is a good indication of the presence of one or more seeded sections in the fruit, the larger side being the seedy portion. Symmetry may indicate complete seediness or complete seedlessness. If the fruit is symmetrical from all angles and at the same time the stem half is distinctly elevated in one or several parts which correspond to the sections inside, the fruit is more or less completely seedy. The elevation is due to the presence of the seed which is always found occupying the stem half more than it does the basal half of the seedy section. On the other hand, if the symmetry is accompanied by a certain pointedness or a tapering appearance or the complete absence of the distinct elevation on the stem half, the fruit may safely be considered as entirely seedless. By seedless in this case is meant the absence of the hard kernel mainly constituting the seed. Seedless segments possess merely a trace of the seed coat which in this case looks more like the "rags" found in the center of the fruit, and is brownish, standing in clear contrast with the transparent edible portion of the fruit. The question has been raised whether absence of elevations may not result also from overcrowding of the fruits in a bunch. It is considered at present that crowding does not exist to such an extent as to prevent the production of elevations due to seediness.

Entire absence of seed is also generally correlated with small size. However, whether the fruits are small or larger, if they are entirely seedless, the correlation between shape and seedlessness still holds. It would be enlightening to report here that the correlation between seedlessness and symmetry of fruit was determined mathematically for 478 fruits, using Yule's formula, $(C=\frac{ad-bc}{ad+bc})$, and this correlation was found to be + 0.741, a very significant index, with a probable error of $\pm$ 0.014. The 478 fruits were first grouped into non-symmetrical and symmetrical classes. Each group was then examined for seedlessness and there were found (a) 208 non-symmetrical, seeded, (b) 102 non-symmetrical, seedless, (c) 39 symmetrical, seeded, and (d) 129 symmetrical, seedless. It will be seen that the correlation is not perfect, but it is very significant, there being a greater error in the correlation between non-symmetry and seededness than in between symmetry and seedlessness. With the above correlation known it should be possible for a retail buyer to select seedless fruits. The habit of selecting seedless fruits in buying should be taught to the people, for once adopted, it may create a big demand for seedless fruits only, and this condition will help in improvement of the lanzon fruit.

Parthenocarpy and seedlessness.—There is a problem which is to be faced in the search for seedless bud mutations. This problem is the presence or absence of parthenocarpy in lanzon. Obviously, if the lanzon is parthenocarpic, that is, if it is capable of producing the fruit without pollination, thereby producing seedless fruits, then, even if a seedless branch is found, there is still the question of whether this seedlessness is a case of bud mutation or one merely of parthenocarpy. If the latter, then the branch or the new plant that may be grown from this may be expected to be seeded the moment pollination takes part during blooming.

It is therefore necessary to study parthenocarpy in the lanzon. The fact that in a given fruit several sections are found seedless while the remaining ones are seedy may be a good indication that the lanzon is parthenocarpic. Moreover, it is known that when fruiting suffers from the effect of bad weather or typhoons, the fruits produced under this condition are invariably seedless, whereas the same tree under normal conditions produces both seeded and seedless fruits in a bunch.

ACKNOWLEDGEMENT

The illustrations accompanying this article were drawn by Mr. Moises Villaluz, the College painter.

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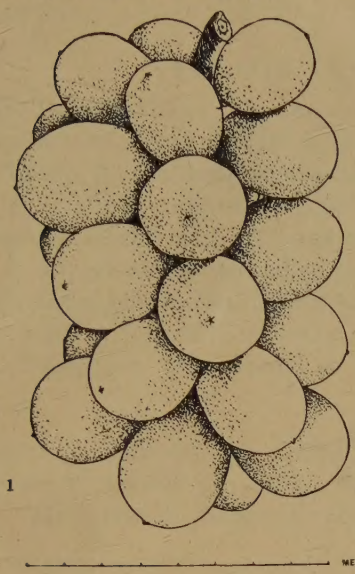
ILLUSTRATIONS

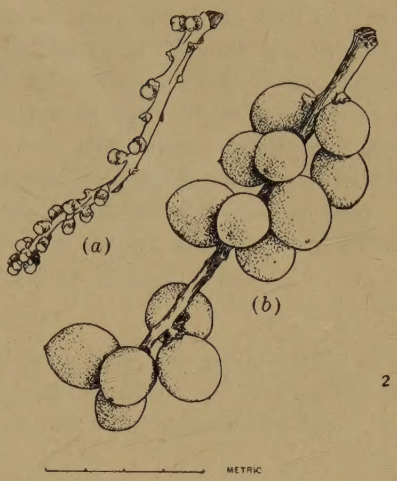
PLATE I

Fig. 1.—Lanzon fruits showing their relative position in the bunch.

Fig. 2.—(*a*) A cluster of flower buds. (*b*) A cluster of undersized fruits resulting from the effect of typhoon. These fruits were seedless.

Fig. 3.—(*a*) A group of asymmetrical fruits showing elevated, seedy sections. (*b*) A group of symmetrical fruits, symmetry being indicative of entire seedlessness. (*c*) Segments of fruits showing seed. (*d*) Segments which are seedless and showing traces of seedcoat inside, but none of the hard kernel of the seed. The seeds removed from the sections and the rags or traces of the seed coat are shown in (*e*) and (*f*) respectively.





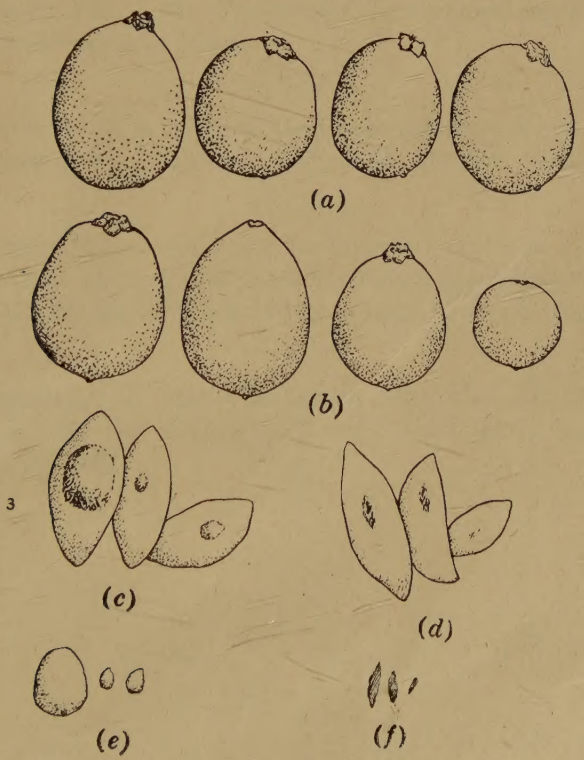


PLATE I.

COLLEGE AND ALUMNI NOTES

Pedro L. Montellano, '15, who was once a member of the staff in the Chemistry Department of this College is now in charge of Animal Husbandry in the Central Luzon Agricultural School at Muñoz, Nueva Ecija. Mr. Montellano, as may be recalled, resigned from his position in the College to accept a post in the Bureau of Education. He was sent as a government pensionado from the Bureau of Education to specialize in Animal Husbandry at the University of Wisconsin where he was conferred the degree of Master of Science in 1921. From there he went to Cornell University where he stayed another year, specializing in Rural Education. He arrived in Manila on June 7, 1922.

Joaquin J. Gonzalez, '19, writes that he is now the proud father of a baby boy born on September 13, 1922. Mr. Gonzalez after his graduation went to farming. He is now in charge of a farm of over one thousand hectares.

Severo G. Yap, '21, was married to Miss Asunción Montesclaros of Cabalian, Leyte, in August 12, 1922. Mr. Yap is now the technical agricultural assistant to the Provincial Governor of Lanao.

Basilio F. Ponce, '22, is the head landscape gardener of the City of Manila. His present address is No. 6, Interior, Cabral St., Ermita, Manila.

Pedro R. Hernais, '22, recently left for Baguio to accept a position in the Bureau of Education. He expects to teach Biology and Geometry in the Baguio High School. Mr. Hernais was a graduate student in this College before he left.

Gaspar Lindayag, '19, passed away, on September 27, at the Philippine General Hospital. He had contracted a fever while taking part in the locust campaign at Nueva Ecija.